4/1/94

# 1.0 RESPONSE TO COMMENTS PREPARED BY THE MICHIGAN DEPARTMENT OF PUBLIC HEALTH

The five remedial alternatives considered in WWES's Focused Feasibility Study (FFS) were specifically requested by the U.S. EPA as potentially applicable for an interim response. At the time the FFS was generated, the remedial investigation had not yet been conducted at the site. Therefore, the limited analytical data available at the time became the basis for the choice of technologies to be reviewed. Based on the existing information, all five of the remedial alternatives were feasible for implementation.

Conceptual design of the systems examined in the FFS were based on very limited information regarding the existing Ingalls well facility and operation of the City of Petoskey's water collection and distribution system. WWES was not permitted to visit the Ingalls well facility and could not obtain any information from the City. In fact, WWES and U.S. EPA personnel were specifically prohibited by City of Petoskey officials from accessing the Ingalls well property during an initial site visit. As a result, the designs are based on information gathered from existing water supply studies generated by McNamee and others.

Based on the comments received from the Michigan Department of Public Health (MDPH), conversations held with MDPH personnel, and the limited information obtained on the City of Petoskey's water system from MDPH, the designs and costs for Alternative 4 - Air Stripping and Alternative 5 - Carbon Treatment, have been revised. System schematics for both alternatives have been included with this letter to further clarify the final layout of the air stripping and carbon treatment systems. No changes have been made to Alternatives 2 and 3, which address the development of alternate sources for the municipal water supply.

The specific comments of the MDPH letter dated January 26, 1994 address deficiencies in the air stripping design. WWES have addressed comments on the potential deficiencies to both air stripping and carbon adsorption, where applicable.

When conflicting values were noted for pumping capacities, etc., information from MDPH comments was utilized. Please note, MDPH comments indicate the maximum demand on the full City's system is 2,200 gpm (1,300 gpm for high pressure, 900 gpm for low pressure). Documentation received via the U.S. EPA indicate the system capacity is 2,500 gpm (1,500 gpm for high pressure, 1,000 gpm for low pressure).

## Specific Comments

Page 2, Comment 1

The initial WWES design of the air stripping and activated carbon systems included a single new pump to deliver water from the well to the treatment system. Existing pumps were intended to be utilized to move the treated ground water into the City's distribution system. After receiving additional input on the existing equipment, the design for both the air stripping and carbon adsorption systems will utilize two new pumps (one as a backup) to deliver water from the well to the treatment system. New pumps have been specified for water distribution to the high pressure district while the existing pumps would be utilized for distribution to the low pressure district. See the attached system schematics and revised cost sheets for both the air stripping and carbon adsorption systems for additional documentation.

Page 2, Comment 2 and 3

Based on new information, WWES understands that the Ingalls well is utilized for the City's entire demand (2,200 gpm) in the event the Lime Kiln well is out of service. The two new well pumps, stripping columns, carbon vessels, and distribution pumps have been redesigned accordingly. See the attached system schematics and revised cost sheets for both the air stripping and carbon adsorption systems for additional documentation.

In the original design, the 50 horsepower pump was intended to deliver water from the Ingalls well to the top of the air stripper only while the existing pumps were to be utilized for treated water distribution. As previously noted above, a second well pump was added to provide backup and new pumps will be utilized for the distribution system.

Page 2, Comment 4

A generator has been added to both the air stripping and carbon adsorption treatment scenarios, to provide power when primary electrical service is disrupted. In the air stripping system, the generator will be of sufficient size to operate one blower, one well pump, one high pressure district pump, one low pressure district pump, and the necessary controls, valves, etc. on one stripping column. In the carbon system, the generator will be of sufficient size to operate one well pump, one high pressure district pump, one low pressure district pump, and the necessary controls, valves, etc. on the carbon vessels. See the attached system schematics and revised cost sheets for both the air stripping and carbon adsorption systems for additional documentation.

Page 2, Comment 5

Based on the information recently received by WWES outlining the operation of the City of Petoskey's water collection and distribution system, new pumps have been specified for the high pressure district while the existing low pressure district pumps will be utilized.

The suction tank which the distribution pumps will feed from, has been increased in capacity to 5,000 gallons in the revised design. The 5,000 gallon tank acts only as a wet well for the distribution pumps to pull from. It is not intended to be utilized as a storage tank. In the event of the loss of the primary well pump, the distribution pumps would also go off-line while the backup well pump comes on-line. Storage capacity in the City's water distribution network are sufficient to provide an adequate supply for the few minutes required to switch to the auxiliary well pump. See the attached system schematics and revised cost sheets for both the air stripping and carbon adsorption systems for additional documentation.

Since the new well pumps will deliver water at a rate slightly above the City's maximum demand, the storage tank will remain full at all times and the extra water will be discharged to Lake Michigan pursuant to the substantive requirements of a NPDES permit. This approach is necessary since both treatment systems operate more efficiently at a constant flow rate.

Page 2, Comment 6

Based on WWES's calculations and modeling efforts, the potential maximum release to the atmosphere from the air stripping system would be less than 200 pounds of VOCs per year. This is well below the maximum limit of 3.1 tons per year regulated by 40 CFR 264 AA under the authority of RCRA. The air strippers would need to meet the substantive requirements of the Clean Air Act for operations, but no system to capture or destroy air emissions would be required. Since this is a CERCLA site, it is our understanding that an air permit would not be required.

Page 2, Comment 7

The buildings originally specified by WWES for the treatment systems were designed to house just the support equipment for the air strippers (blowers, controls, electrical) and both the vessels and support equipment for the activated carbon system. The air strippers themselves were to be insulated and located outside the building. The existing pump house was anticipated to continue to be utilized for distribution pumps.

The information WWES received on the City of Petoskey's water system did not include any information regarding the size of the existing pump house or other usable buildings at the Ingalls Avenue site. Therefore, the WWES design continues to assume that the existing structure(s) are of sufficient size to house all of the new distribution pumps and any existing equipment anticipated to be re-utilized. New structure costs have been included to accommodate support equipment (electrical, controls, etc.) for the air stripping system, and the carbon cells and support equipment of the adsorption system. It is possible that sufficient space remains in the existing structure to house support equipment for either treatment system, thereby removing the need for a new structure, except in the case of the carbon adsorption cells.

Please note that the structures in question are anticipated to be insulated Morton buildings or the equivalent. No provision has been made to replace existing Water Department facilities such as offices, locker rooms, etc. See the attached system schematics and revised cost sheets for both the air stripping and carbon adsorption systems for additional documentation.

Page 3, Comment 8

The revised cost estimates are attached and include laboratory costs. *(Teresa, how do you wish to handle the GC issue?)*

Page 3, Paragraph 1

The costs for controls, valving, piping, and other appurtenances for both the air stripping and carbon treatment systems were based on utilizing existing piping wherever possible. Additional costs have been included for new piping runs between the well and the treatment system. The components are intended to be constructed of standard engineering materials, e.g. general purpose controls/electrical, carbon steel valves, ductile iron pipe, etc. No special requirements are known to WWES requiring stainless steel or other specialized materials of construction for potable water systems.

The stripping columns are designed to be constructed of UV-stabilized fiberglass reinforced plastic (FRP), which can be obtained in a sufficiently high grade to provide a 30-year operating life. The carbon adsorption vessels are to be constructed of carbon steel. See the attached system schematics and revised cost sheets for both the air stripping and carbon adsorption systems for additional documentation.

Page 3, Paragraph 2

WWES has revised the designs of both the air stripping and carbon adsorption treatment systems based on information recently received from the MDPH and the City of Petoskey. The information addresses the design and operation of the existing water collection and distribution system. The revised design addresses the issue of system reliability for municipal water systems. See the attached system schematics and revised cost sheets for both the air stripping and carbon adsorption systems for additional documentation.

## 2.0 RESPONSE TO COMMENTS BY THE TIP OF THE MITT WATERSHED COUNCIL

Specific Comments

Page 1, Item 1, First Bullet.

The analytical data collected during the remedial investigation indicated the presence of semi-volatile organic compounds and inorganic pollutants in the soils surrounding the PMC facility. These analytical data were not available during the preparation of the initial FFS, and were therefore not utilized in the examination of potential remedial alternatives.

Based on our review of the analytical data collected at the site, it does not appear that the combination of volatile organic compounds (solvents) and semi-volatile organic compound contamination of source area soils have resulted in the movement of semi-volatile organic compounds into the ground water to any great extent. In fact, only one monitoring well sampled during the remedial investigation detected a one semi-volatile organic compound at a very low concentration, (specifically, a polynuclear aromatic hydrocarbon (PNA) compound). Several phthalates were detected in ground water during the RI; however some of these chemicals were also present in blank samples and their presence could be due to laboratory contamination. This issue should be addressed as part of the RI. Furthermore, PNAs have never been detected in ground water collected from Ingalls well. This indicates strong bonding of the semi-volatile organic compounds in the soil matrix. The source has existed for 13 years and as such, it seems reasonable to assume that the PNAs will not suddenly become more mobile.

Generally, air stripping is not a preferred treatment technology for PNAs, however, there is no indication that any group of compounds other than volatile organic compounds (which are very amenable to air stripping) have been detected to date in ground water collected from either the Ingalls well or surrounding monitoring wells. WWES believes that ground water impacted with semi-volatile organic compounds and inorganic analytes will likely not reach the Ingalls well. Since the Focused Feasibility Study submitted to the U.S. EPA was intended to determine an effective interim solution to the Ingalls well contamination, air stripping is still an effective remedial alternative. Any future indication of ground water impacted with inorganic analytes moving toward the Ingalls well would warrant a future response. U. S. EPA may consider other treatment technologies that would treat ground water impacted with other groups of compounds (see responses to comments on the Interim Feasibility Study) during the Final Feasibility Study.

WWES agrees that the proposed treatment alternative will not bring the well into compliance with Michigan Department of Public Health criteria. The Ingalls well does not meet many of these criteria even without the added complication of contamination associated with the PMC site. Furthermore, the proposed alternative is not intended to remedy problems other than those associated with ground water impacted by the PMC site.

## 3.0 RESPONSE TO COMMENTS PREPARED BY McNAMEE INDUSTRIAL SERVICES, INC. FOR THE CITY OF PETOSKEY

### 3.1 McNamee Section 1.0 Summary

*Terese, please insert your response*

### 3.2 McNamee Section 2.0 Background

*Terese, please insert your response*

### 3.3 McNamee Section 3.0 Response Action Activities

*Terese, please insert your response*

### 3.4 McNamee Section 4.0 Risk Assessment

The *Baseline Risk Assessment for Ground Water* was prepared for the U. S. EPA in order to determine if the risks due the presence of chemicals in the ground water and the Ingalls wells justified an **interim** response. The U. S. EPA determined that the results of the risk assessment did justify an interim response. The scope of the risk assessment did not include the evaluation of soil contamination. In addition, the *Baseline Risk Assessment for Ground Water* was also prepared before the Remedial Investigation (RI) was completed, and analytical data generated by the RI were not available at the time the risk assessment was prepared.

The MDNR is conducting a RI of the site, which will be used to support a **final** response to all of the chemical contamination found at the site. Risk Assessments are generally prepared in conjunction with the RI. Many of the comments on the *Baseline Risk Assessment for Ground Water* are more appropriate for the risk assessment that should be prepared in conjunction with the RI. WWES suggests that these comments be considered by the MDNR during its preparation of the Risk Assessment in conjunction with the RI.

## Specific Comments

We concur that "hazardous substances" have been reported in the soils at the PMC facility and in the ground water from the monitoring wells downgradient of the facility. However, these substances have not been detected in ground water samples taken from the Ingalls well. Furthermore, the nature of these chemicals tends to bind them to the soil matrix, substantially reducing their mobility. Clearly, after thirteen years, it is not reasonable to assume that these substances will become more mobile.

Page 6, Section 4.0, Paragraph 1

WWES agrees that these factors may have led to an underestimation the risks, and these were acknowledged in the risk assessment. Regarding the comment on other exposure pathways, see the response to the comment on Page 10, Paragraphs 4 and 5.

Page 6, Section 4.0, Paragraph 2

The risk assessment considered all of the ground water data available at the time of preparation and recognized the deficiencies in these data.

Page 6, Section 4.0, Paragraph 3

WWES agrees that the analytical data on vinyl chloride that has become available since the risk assessment was prepared would have an impact on the potential risks associated with use of this water.

Page 6, Section 4.0, Paragraph 4

WWES agrees that degradation of some chemicals in the soil could create degradation products such as vinyl chloride. Vinyl chloride was analyzed for, but was never detected in the analytical data used for the risk assessment. However, vinyl chloride was detected in only 1 of 64 ground water samples collected during the RI. This is still a concern, but it is not evidence of substantial production of vinyl chloride by degradation of other chemicals.

Page 7, Section 4.0, Paragraphs 1 and 2

These analytical data were not available when the risk assessment was prepared. The presence of methylene chloride and bis-(2-ethylhexyl) phthalate in ground water would raise the risks associated with exposure to this water (unless the presence of these chemicals is due to laboratory contamination). See previous response to Tipp of the Mitt comments regarding laboratory contamination.

Page 7, Section 4.0, Paragraph 3

WWES agrees with this comment. The evaluation of risks due to soil contamination was not included in the scope of the risk assessment, and these analytical data were not available when the risk assessment was prepared. WWES notes that only one polynuclear aromatic hydrocarbon (pyrene) was detected in any ground water samples collected during the RI, and this indicates that these chemicals are tightly bound to the soil and are virtually immobile.

Page 7, Section 4.0, Paragraph 4

WWES agrees that the concentrations of PNAs in soil reported in the RI are probably above background concentrations. However, there is little evidence (see above comment) to indicate that these chemicals have migrated to ground water.

Page 7, Section 4.0, Paragraph 5

The risk assessment does not mention these data regarding dibenzofurans because they were not available when the risk assessment was prepared. In addition, dibenzofurans were not detected in the ground water during the RI.

Page 8, Section 4.0, Paragraph 1

The phthalate data were not available when the risk assessment was prepared. Also, see previous comment regarding laboratory blank contamination.

Page 8, Section 4.0, Paragraph 2

The trihalomethane data were not available when the risk assessment was prepared. WWES agrees that the presence of these chemicals in the ground water may indicate that the trihalomethanes in the Ingalls well may not be due only to chlorination.

Page 8, Section 4.1, Paragraph 3

The risk assessment discusses the same limitations with the analytical data available at the time that are mentioned here. All of the chemicals detected in the Ingalls well or the monitoring wells from 1989 to March 1992 were considered chemicals of potential concern except for trihalomethanes. The RI data were not available at the time the risk assessment was prepared.

WWES agrees the Ingalls well has been impacted by contamination; however, according to earlier McNamee investigations, Lake Michigan is the source of most of the water from the Ingalls well rather than ground water.

Page 10, Section 4.1, Paragraphs 1, 2, and 3

WWES agrees that the risks should be re-evaluated considering the data collected during the RI, and other available data. This evaluation should be included in the risk assessment in conjunction with the MDNR RI.

Page 10, Section 4.2, Paragraph 4

Potential exposures due to recreational and residential activities were beyond the scope of the *Baseline Risk Assessment for Ground Water*. These exposure routes should be evaluated in the risk assessment performed in conjunction with the MDNR RI.

Page 10, Section 4.2, Paragraph 5

WWES agrees that other domestic activities such as dishwashing and laundering may represent additional exposure routes that were not considered. However, the risks associated with these exposure routes are probably insignificant. The risks associated with showering are 1 to 4 orders of magnitude less than the risks associated with ingestion of the water (see Table 5-1 in the *Baseline Risk Assessment for Ground Water*). Risks associated with washing will probably be even less. These risks are very unlikely to significantly affect the results of the risk assessment. Any such estimates would also be very uncertain because the models used to predict exposure concentrations from these activities are not well developed.

Page 11, Section 4.2, Paragraphs 1 and 2

WWES agrees with this comment. However, such synergistic interactions of chemicals are very poorly known, and there is no technical basis for estimating risks except for a very few chemical combinations. Antagonistic interactions are also possible, but are also very poorly known.

Page 11, Section 4.2, Paragraph 3.

Data for the Ingalls well collected before 1989 were not included in the risk assessment because these data were very incomplete and of uncertain quality. This exclusion of early data is provided for in U. S. EPA Guidance (*Risk Assessment Guidance for Superfund. Volume 1. Human Health Evaluation Manual.* page 5-2) and was done in consultation with the U.S. EPA Remedial Project Manager. All of the data could be used to develop estimated concentrations of chemicals in the water for the entire exposure period as suggested in this comment. This approach would probably result in lower estimates of risk because the concentrations have decreased considerably and will probably continue to do so. The risk assessment made a conservative assumption that the concentrations will remain constant for the exposure period.

Page 11, Section 4.3, Paragraph 4

WWES does not agree that the risk assessment failed to meet its objectives.

Page 12, Section 4.4, Paragraph 1

The information regarding release of BTEX and metals was not available when the risk assessment was prepared.

Page 12, Section 4.4, Paragraphs 4 and 5

PNAs were not included in the risk assessment because there were no data indicating their presence in the ground water when the risk assessment was prepared, not, as stated here because of their limited mobility (although this is also true). PNAs were not detected in the Ingalls well during the RI and only one PNA (pyrene) was detected on one occasion in ground water at a very low concentration. If PNAs were being mobilized by solvents, one would expect to find PNAs in the ground water with solvents. There is no evidence to suggest that solvents are mobilizing PNAs at the site.

Page 13, Section 4.4, Paragraph 2 (indented)

A new drinking water source is only one possible remedy. It is not clear how the risks of a new drinking water source could be evaluated before the source is identified and studied. If the comment means that risks associated with the Ingalls well should be reevaluated considering new information, this comment should be addressed to the MDNR to consider during the preparation of their risk assessment as part of the remedial investigation.

Page 13, Section 4.4, Paragraph 3 (indented)

This comment should be considered by the MDNR during preparation of the risk assessment as part of the RI.

Page 13, Section 4.5, Paragraph 4

The data in Tables 4, 5, and 6 of the comments were not available when the risk assessment was prepared. Only the data from 1989 presented in Table 3 of the comments were included the risk assessment (Tables 2-1 and 2-2). The response to the comment on Page 11, Paragraph 3, presents the rationale for excluding the earlier data. Cumulative risks were evaluated in the risk assessment. U. S. EPA guidance does not require that all data collected should be evaluated. In fact, probably none of the data used in the risk assessment would have met data useability criteria in U. S. EPA guidance (*Guidance for Data Useability in Risk Assessment*. 1990. EPA/540/G-90/008). This guidance was not applied because the U. S. EPA and WWES realized it would exclude most or all of the data and it would not have been possible to prepare a risk assessment. The comments of the MDNR toxicologist were addressed in an earlier letter.

Page 13-14, Section 4.4, Paragraph 5

WWES does not agree that all of the chemicals detected in ground water prior to 1989 should be included (see previous comment). All of the chemicals detected except for trihalomethanes and appropriate toxicological information were included in the risk assessment.

Page 14, Section 4.6, Paragraph 1

All chemicals detected between 1989 and 1991 except trihalomethanes were included in the risk assessment and the intent was to include as many chemicals as could reasonably be attributed to the site. Deficiencies in the data were clearly noted in the risk assessment. Inclusion of additional data from earlier than 1989 or after 1991 may actually result in lower risk estimates. The chemicals were not "preselected to preclude accurate risk" as stated in this comment, and the comment provides no specific information to support this assertion. The chemicals were selected using best professional judgment, U. S. EPA guidance, and the most reliable data available at the time.

Page 14, Section 4.6, Paragraph 2

The deficiencies of the data base were noted in the risk assessment.

Page 14, Section 4.6, Paragraph 3

The U. S. EPA guidance document used to calculate PRGs was referenced and the chemicals with sample quantitation limits above the PRGs were identified in Appendix A of the risk assessment.

Page 14, Section 4.6, Paragraph 4

Limitations of the data were clearly noted in the risk assessment. With only a few exceptions, there is no technical basis for evaluating synergistic or antagonistic effects in any risk assessment. The chemicals identified in ground water collected during the RI are not known to have synergistic effects (*Casarett and Doull's Toxicology*. 1980). The recent data generated by the RI could result in lower as well as higher estimates of risk. Maximum Contaminant Level Goals (MCLGs) are not enforceable and are not ARARs.

Page 14, Section 4.6, Paragraph 5

The interim remedy was selected to be protective of the public health. The new chemical data available for the Ingalls well was evaluated and as such, carbon adsorption has been added as a refinement to the originally proposed remedy.

### 3.5 McNamee Section 5.0 Summary of Remedial Investigations

Page 15, Section 5.2, Paragraph 3

Samples taken from the Ingalls well do not contain phthalates at concentrations exceeding Act 307 Type B ground water criteria.

Page 15, Paragraph 4, Section 5.2

The presence of these chemicals in ground water should be evaluated by the MDNR as part of the RI. Table 1 compares the concentrations of all of the chemicals detected in ground water during the RI to the maximum contaminant levels (MCLs). Concentrations of trichloroethene and bis(s-ethylhexyl)phthalate have exceeded the MCLs and the single detection of vinyl chloride was at the MCL. It is our understanding that no individuals are directly exposed to this ground water at present.

Page 16, Section 5.2, Paragraph 1

The increases in TCE and DCE are not significant and are probably the result of normal fluctuations in ground water quality or the analytical methods. If a DNAPL were to exist at the site, the concentrations of dissolved constituent would be anticipated to be three to four orders of magnitude higher based on the solubility of the chemicals.

Page 16, Section 5.2, Paragraph 2.

Vinyl chloride was detected only once. However, it is possible that concentrations of vinyl chloride may increase as other chemicals degrade. This should be addressed in the RI. The remedy selected by the U. S. EPA will effectively remove vinyl chloride from the Ingalls well.

### 3.6 McNamee Section 6.0 Application of Applicable or Relevant and Appropriate Requirements

*Terese, please insert your response*

### 3.7 McNamee Section 7.0 Remedial Alternatives, Page 17

The five remedial alternatives considered in WWES's Focused Feasibility Study (FFS) were specifically requested by the U.S. EPA as potentially applicable for an interim response. At the time the FFS was generated, the MDNR remedial investigation of the sites had not yet started. Therefore, the choice of specific technologies reviewed were based on the limited analytical data available at the time. Based on the existing information, all five of the remedial alternatives were feasible for implementation.

WWES does not agree with McNamee's decision to exclude air stripping treatment as an applicable remedial alternative for the ground water from the Ingalls well. Analyses of the water collected by the Ingalls well indicates no presence of PNAs or other compounds which would not be removed sufficiently by air stripping. In fact, only one monitoring well sample indicated the presence of PNAs in ground water, indicating that the PNAs are tightly bound within the soil matrix. Exposure of the PNAs in the soils at the PMC site to solvents has not yet indicated any increased mobility of the PNAs to date, so it seems unreasonable to assume that the PNAs will suddenly begin moving toward the Ingalls well.

Specific Comments

Page 19, Section 7.4.1, Paragraphs 1 through 3

All technologies reviewed in McNamee's document are technically feasible. McNamee has focused on the alternative specifying carbon adsorption for remediation of the ground water. The description of the operations of such a system are adequate and reflect the description given in "Alternative Five: Treatment of Ground Water Using GAC Adsorption" from the initial FFS.

Page 19, Section 7.4.2, Paragraphs 4 and 5

The costs given for the construction and operation of a activated carbon treatment system are significantly higher than the costs developed by WWES for a similar system. It is WWES's opinion that an adequate system to treat the contaminated well water, but not replace any existing water department facilities, could be constructed for less capital expense. WWES does not see the need for a full-time superintendent and operators at a new treatment facility, since it is assumed that the City of Petoskey currently employs such personnel.

## 3.8 McNamee Section 8.0 Comparative Analysis of Alternatives

*Terese, please insert your response*

**Table 1**
**Summary of Contaminants Detected in the Groundwater in the Aquifer (1992-1993)**

| Contaminant | Range of Detected Concentration (ppb) | Maximum Contaminant Level (ppb) |
|---|---|---|
| Acetone | 0.9 - 15 | NA |
| Carbon Disulfide | 0.6 - 3 | NA |
| Chloroform (Trihalomethanes) | 0.7 - 4 | 100 T |
| Bromodichloromethane (Trihalomethanes) | 0.5 - 3 | 100 T |
| Trichloroethylene | 0.4 - 83 | 5 |
| Tetrachloroethene | 0.9 -2 | 5 |
| Methyl t-Butyl Ether | 0.5 - 8 | NA |
| Vinyl Chloride | 2 | 2 |
| Methylene Chloride | 0.5 - 3 | 5 |
| Cis-1,2-Dichloroethene | 0.4 - 4 | 70 |
| Dibromochloroethane | 0.5 - 2 | NA |
| Toluene | 0.6 | 1,000 |
| 1,1,1-Trichloroethane | 0.5 - 0.7 | 200 |
| Diethylphthalate | 1 | NA |
| bis(2-Ethylhexyl)Phthalate | 0.5 - 7 | 6 |
| gamma Chlordane | 0.015 - 1.1 | 2 |
| Di-n-Octylphthalate | 0.6 - 7 | NA |
| Di-n-Butylphthalate | 0.7 - 0.7 (?) | NA |
| Butylbenzylphthalate | 0.6 - 1 | 100 |
| Pyrene | 0.7 | NA |
| delta - BHC | 0.034 | 0.2 |
| Heptachlor | 0.028 | 0.4 |
| Aldrin | 0.026 | NA |
| Heptachlor Epoxide | 0.007 | 0.2 |
| Endosulfan I | 0.019 | NA |
| Dieldrin | 0.008 | NA |
| 4,4-DDE | 0.068 | NA |
| 4,4-DDT | 0.008 - 0.027 | NA |
| Endrin Aldehyde | 0.15 - 0.20 | NA |
| alpha - Chlordane | 0.015 - 0.016* | 2 |
| alpha - BHC | 0.005 | 0.2 |

Note: Data obtained from the report summarizing the results of the remedial investigation (RI) as issued by the MDNR on January 14, 1994.

T = Total cannot exceed 100 ug/l for all trihalomethanes
NA = Not available
Source: McNamee Industrial Services, Inc. (January 1994)

## ALTERNATIVE FOUR: TREATMENT OF GROUNDWATER USING AIR STRIPPING

## CAPITAL COSTS

| QTY | UNIT | DESCRIPTION | UNIT COST | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|
| | | MAJOR EQUIPMENT | | | |
| 2 | EA | Stripper Shell (FRP-14' diam.) | $45,000 | $90,000 | |
| 2 | LS | Packing Support/Liquid Distr. | $42,500 | $85,000 | |
| 4,620 | CF | Packing | $9 | $41,580 | |
| 2 | EA | Blower (12,000 cfm, 40hp) | $6,500 | $13,000 | |
| 2 | EA | Vert Well Pump (2200 gpm, 40 hp) | $11,300 | $22,600 | |
| 3 | EA | HP Centr. Pump (700 gpm, 100 hp) | $14,500 | $43,500 | |
| 1 | EA | Standby Generator - Diesel | $80,000 | $80,000 | |
| 1 | EA | 500 gal Aboveground Fuel Tank | $2,000 | $2,000 | |
| 1 | EA | CS Suction Tank (5,000 gal) | $8,000 | $8,000 | $385,700 |
| | | ANCILLARY EQUIPMENT | | | |
| 1 | LS | Piping/Valves/Appurtanences | $49,000 | $49,000 | |
| 1 | LS | Controls | $26,500 | $26,500 | |
| 1 | LS | Electrical | $33,000 | $33,000 | |
| 1 | LS | Insulation | $10,000 | $10,000 | |
| 1 | LS | Shipping | $16,500 | $16,500 | $135,000 |
| | | SITE PREPARATION | | | |
| 1 | LS | Earth Work | $5,000 | $5,000 | |
| 30 | CY | Foundation (35' x 20') | $300 | $9,000 | |
| 700 | LF | Site Fence | $15 | $10,500 | $24,500 |
| | | INSTALLATION | | | |
| 1 | LS | Mechanical | $66,000 | $66,000 | |
| 1 | LS | Electrical (15% of ME) | $33,000 | $33,000 | |
| 1 | EA | Structure (20' x 20' x 10') | $22,000 | $22,000 | |
| 1 | LS | 18" Gravity Sewer -NPDES dischg | $42,000 | $42,000 | |
| 1 | LS | Relocate/Refit Chemical Systems | $5,000 | $5,000 | $168,000 |
| | | INDIRECT | | | |
| 1 | LS | Engineering/Constr. Man. (20% of Installed Cost) | | | $142,600 |
| 1 | LS | Contingency (10% of Installed Cost) | | | $71,300 |
| 1 | LS | Pilot Treatability Study | | | $40,000 |
| | | | | TOTAL | $967,000 |

**ALTERNATIVE FIVE: TREATMENT OF GROUNDWATER USING GAC ADSORPTION**

**CAPITAL COSTS**

| QTY | UNIT | DESCRIPTION | UNIT COST | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|
| | | MAJOR EQUIPMENT | | | |
| 6 | EA | Carbon Cells/Carbon | $70,000 | $420,000 | |
| 2 | EA | Vert Well Pump (2200 gpm, 40 hp) | $11,300 | $22,600 | |
| 3 | EA | HP Centr. Pump (700 gpm, 100 hp) | $14,500 | $43,500 | |
| 1 | EA | Standby Generator - Diesel | $70,000 | $70,000 | |
| 1 | EA | 500 gal Aboveground Fuel Tank | $2,000 | $2,000 | |
| 1 | EA | CS SuctionTank (5,000 gal) | $8,000 | $8,000 | $566,100 |
| | | ANCILLARY EQUIPMENT | | | |
| 1 | LS | Piping/Valves/Appurtanences | $65,000 | $65,000 | |
| 1 | LS | Controls | $28,500 | $28,500 | |
| 1 | LS | Electrical | $45,000 | $45,000 | |
| 1 | LS | Shipping | $28,500 | $28,500 | $167,000 |
| | | SITE PREPARATION | | | |
| 1 | LS | Earth Work | $7,000 | $7,000 | |
| 40 | CY | Foundation (40' x 40') | $300 | $12,000 | |
| 700 | LF | Site Fence | $15 | $10,500 | $29,500 |
| | | INSTALLATION | | | |
| 1 | LS | Mechanical | $85,000 | $85,000 | |
| 1 | LS | Electrical | $56,500 | $56,500 | |
| 1 | EA | Structure (40' x 40' x 15') | $75,000 | $75,000 | |
| 1 | LS | 18" Gravity Sewer -NPDES dischg | $42,000 | $42,000 | |
| 1 | LS | Relocate/Refit Chemical Systems | $5,000 | $5,000 | $263,500 |
| | | INDIRECT | | | |
| 1 | LS | Engineering/Constr. Man. (20% of Installed Cost) | | | $205,200 |
| 1 | LS | Contingency (10% of Installed Cost) | | | $102,600 |
| 1 | LS | Pilot Treatability Study | | | $25,000 |
| | | | | TOTAL | $1,359,000 |

## ALTERNATIVE FOUR: TREATMENT OF GROUNDWATER USING AIR STRIPPING

## ANNUAL OPERATING COSTS

| | DESCRIPTION | UNIT | QTY | UNIT PRICE | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|---|
| 1. | STRIPPER OPERATION | | | | | |
| | Electricity (constant blower and pump op) | KWHR | 750,000 | $0.08 | $60,000 | |
| | Building Heating (winter operation) | LS | 1 | $7,500 | $7,500 | |
| | System Monitoring (2 hr/day; 365 days/yr) | HR | 730 | $35 | $25,550 | $93,100 |
| 2. | SAMPLING | | | | | |
| | Stripper Influent/Effluent (2 hr/week; 52 weeks/yr) | HR | 104 | $35 | $3,640 | |
| | Monitoring Wells (2 days quarterly; 2 technicians) | HR | 160 | $35 | $5,600 | |
| | Equipment (containers,etc.) | LS | 1 | $5,000 | $5,000 | |
| | Air Monitoring (1 hr/day; 365 days/yr) | HR | 365 | $35 | $12,775 | $27,000 |
| 3. | ANALYTICAL | | | | | |
| | Weekly Influent/Effluent | EA | 52 | $450 | $23,400 | |
| | Quarterly Monitoring Wells (6 wells; duplicate analyses) | EA | 4 | $1,350 | $5,400 | $28,800 |
| 4. | Packing Change (every 10 years) | | | | | |
| | Replacement Packing | CF | 470 | $9 | $4,230 | |
| | Equipment Rental | DAY | 0.4 | $100 | $40 | |
| | Labor | HR | 4 | $35 | $140 | |
| | Transport/Disposal | TON | 0.8 | $50 | $40 | $4,500 |
| 5. | MISCELLANEOUS REPAIRS (10%) | | | | | $15,300 |
| | | | | | TOTAL | $169,000 |

**ALTERNATIVE FIVE: TREATMENT OF GROUNDWATER USING GAC ADSORPTION**

**ANNUAL OPERATING COSTS**

| DESCRIPTION | UNIT | QTY | UNIT PRICE | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|
| 1. CARBON CELL OPERATION | | | | | |
| Electricity (constant pump op) | KWHR | 600,000 | $0.08 | $48,000 | |
| Building Heating (winter operation) | LS | 1 | $10,000 | $10,000 | |
| System Monitoring (2 hr/day; 365 days/yr) | HR | 730 | $35 | $25,550 | $83,600 |
| 2. SAMPLING | | | | | |
| Carbon Influent/Effluent (2 hr/week; 52 weeks/yr) | HR | 104 | $35 | $3,640 | |
| Monitoring Wells (2 days quarterly; 2 techs) | HR | 160 | $35 | $5,600 | |
| Equipment (containers,etc.) | LS | 1 | $7,500 | $7,500 | |
| Air Monitoring (1 hr/day; 365 days/yr) | HR | 365 | $35 | $12,775 | $29,500 |
| 3. ANALYTICAL | | | | | |
| Weekly Influent/Effluent | EA | 52 | $450 | $23,400 | |
| Quarterly Monitoring Wells (6 wells; duplicate analyses) | EA | 4 | $1,350 | $5,400 | $28,800 |
| 4. CARBON CHANGE (5 cells/3 years; $27,000/change) | LS | 1 | $45,000 | $45,000 | $45,000 |
| 5. MISCELLANEOUS REPAIRS (10%) | | | | | $18,700 |
| | | | | TOTAL | $206,000 |

**ALTERNATIVE FOUR: NPV CALCULATION**

| **INTEREST RATE:** | **0.05** | Investment: | $967,000 |
|---|---|---|---|
| | | Annual Expenses: | $169,000 |

| YEAR | INVESTMENT | EXPENSES | CASH FLOW | DISCOUNT FACTOR | DISCOUNTED CASH FLOW |
|---|---|---|---|---|---|
| 0 | $967,000 | $0 | ($967,000) | 1.000 | ($967,000) |
| 1 | $0 | $169,000 | ($169,000) | 0.952 | ($160,952) |
| 2 | $0 | $169,000 | ($169,000) | 0.907 | ($153,288) |
| 3 | $0 | $169,000 | ($169,000) | 0.864 | ($145,989) |
| 4 | $0 | $169,000 | ($169,000) | 0.823 | ($139,037) |
| 5 | $0 | $169,000 | ($169,000) | 0.784 | ($132,416) |
| 6 | $0 | $169,000 | ($169,000) | 0.746 | ($126,110) |
| 7 | $0 | $169,000 | ($169,000) | 0.711 | ($120,105) |
| 8 | $0 | $169,000 | ($169,000) | 0.677 | ($114,386) |
| 9 | $0 | $169,000 | ($169,000) | 0.645 | ($108,939) |
| 10 | $0 | $169,000 | ($169,000) | 0.614 | ($103,751) |
| 11 | $0 | $169,000 | ($169,000) | 0.585 | ($98,811) |
| 12 | $0 | $169,000 | ($169,000) | 0.557 | ($94,106) |
| 13 | $0 | $169,000 | ($169,000) | 0.530 | ($89,624) |
| 14 | $0 | $169,000 | ($169,000) | 0.505 | ($85,356) |
| 15 | $0 | $169,000 | ($169,000) | 0.481 | ($81,292) |
| 16 | $0 | $169,000 | ($169,000) | 0.458 | ($77,421) |
| 17 | $0 | $169,000 | ($169,000) | 0.436 | ($73,734) |
| 18 | $0 | $169,000 | ($169,000) | 0.416 | ($70,223) |
| 19 | $0 | $169,000 | ($169,000) | 0.396 | ($66,879) |
| 20 | $0 | $169,000 | ($169,000) | 0.377 | ($63,694) |
| 21 | $0 | $169,000 | ($169,000) | 0.359 | ($60,661) |
| 22 | $0 | $169,000 | ($169,000) | 0.342 | ($57,773) |
| 23 | $0 | $169,000 | ($169,000) | 0.326 | ($55,022) |
| 24 | $0 | $169,000 | ($169,000) | 0.310 | ($52,401) |
| 25 | $0 | $169,000 | ($169,000) | 0.295 | ($49,906) |
| 26 | $0 | $169,000 | ($169,000) | 0.281 | ($47,530) |
| 27 | $0 | $169,000 | ($169,000) | 0.268 | ($45,266) |
| 28 | $0 | $169,000 | ($169,000) | 0.255 | ($43,111) |
| 29 | $0 | $169,000 | ($169,000) | 0.243 | ($41,058) |
| 30 | $0 | $169,000 | ($169,000) | 0.231 | ($39,103) |
| Totals: | $967,000 | $5,070,000 | ($6,037,000) | | ($3,564,944) |

## ALTERNATIVE FIVE: NPV CALCULATION

| | | | |
|---|---|---|---|
| **INTEREST RATE:** | **0.05** | Investment: | $1,359,000 |
| | | Annual Expenses: | $206,000 |

| YEAR | INVESTMENT | EXPENSES | CASH FLOW | DISCOUNT FACTOR | DISCOUNTED CASH FLOW |
|---|---|---|---|---|---|
| 0 | $1,359,000 | $0 | ($1,359,000) | 1.000 | ($1,359,000) |
| 1 | $0 | $206,000 | ($206,000) | 0.952 | ($196,190) |
| 2 | $0 | $206,000 | ($206,000) | 0.907 | ($186,848) |
| 3 | $0 | $206,000 | ($206,000) | 0.864 | ($177,951) |
| 4 | $0 | $206,000 | ($206,000) | 0.823 | ($169,477) |
| 5 | $0 | $206,000 | ($206,000) | 0.784 | ($161,406) |
| 6 | $0 | $206,000 | ($206,000) | 0.746 | ($153,720) |
| 7 | $0 | $206,000 | ($206,000) | 0.711 | ($146,400) |
| 8 | $0 | $206,000 | ($206,000) | 0.677 | ($139,429) |
| 9 | $0 | $206,000 | ($206,000) | 0.645 | ($132,789) |
| 10 | $0 | $206,000 | ($206,000) | 0.614 | ($126,466) |
| 11 | $0 | $206,000 | ($206,000) | 0.585 | ($120,444) |
| 12 | $0 | $206,000 | ($206,000) | 0.557 | ($114,709) |
| 13 | $0 | $206,000 | ($206,000) | 0.530 | ($109,246) |
| 14 | $0 | $206,000 | ($206,000) | 0.505 | ($104,044) |
| 15 | $0 | $206,000 | ($206,000) | 0.481 | ($99,090) |
| 16 | $0 | $206,000 | ($206,000) | 0.458 | ($94,371) |
| 17 | $0 | $206,000 | ($206,000) | 0.436 | ($89,877) |
| 18 | $0 | $206,000 | ($206,000) | 0.416 | ($85,597) |
| 19 | $0 | $206,000 | ($206,000) | 0.396 | ($81,521) |
| 20 | $0 | $206,000 | ($206,000) | 0.377 | ($77,639) |
| 21 | $0 | $206,000 | ($206,000) | 0.359 | ($73,942) |
| 22 | $0 | $206,000 | ($206,000) | 0.342 | ($70,421) |
| 23 | $0 | $206,000 | ($206,000) | 0.326 | ($67,068) |
| 24 | $0 | $206,000 | ($206,000) | 0.310 | ($63,874) |
| 25 | $0 | $206,000 | ($206,000) | 0.295 | ($60,832) |
| 26 | $0 | $206,000 | ($206,000) | 0.281 | ($57,936) |
| 27 | $0 | $206,000 | ($206,000) | 0.268 | ($55,177) |
| 28 | $0 | $206,000 | ($206,000) | 0.255 | ($52,549) |
| 29 | $0 | $206,000 | ($206,000) | 0.243 | ($50,047) |
| 30 | $0 | $206,000 | ($206,000) | 0.231 | ($47,664) |
| Totals: | $1,359,000 | $6,180,000 | ($7,539,000) | | ($4,525,725) |

## ALTERNATIVE FOUR: TREATMENT OF GROUNDWATER USING AIR STRIPPING

## CAPITAL COSTS

| QTY | UNIT | DESCRIPTION | UNIT COST | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|
| | | MAJOR EQUIPMENT | | | |
| 2 | EA | Stripper Shell (FRP-14' diam.) | $45,000 | $90,000 | |
| 2 | LS | Packing Support/Liquid Distr. | $42,500 | $85,000 | |
| 4,620 | CF | Packing | $9 | $41,580 | |
| 2 | EA | Blower (12,000 cfm, 40hp) | $6,500 | $13,000 | |
| 2 | EA | Vert Well Pump (2200 gpm, 40 hp) | $11,300 | $22,600 | |
| 3 | EA | HP Centr. Pump (700 gpm, 100 hp) | $14,500 | $43,500 | |
| 1 | EA | Standby Generator - Diesel | $80,000 | $80,000 | |
| 1 | EA | 500 gal Aboveground Fuel Tank | $2,000 | $2,000 | |
| 1 | EA | CS Suction Tank (5,000 gal) | $8,000 | $8,000 | $385,700 |
| | | ANCILLARY EQUIPMENT | | | |
| 1 | LS | Piping/Valves/Appurtanences | $49,000 | $49,000 | |
| 1 | LS | Controls | $26,500 | $26,500 | |
| 1 | LS | Electrical | $33,000 | $33,000 | |
| 1 | LS | Insulation | $10,000 | $10,000 | |
| 1 | LS | Shipping | $16,500 | $16,500 | $135,000 |
| | | SITE PREPARATION | | | |
| 1 | LS | Earth Work | $5,000 | $5,000 | |
| 30 | CY | Foundation (35' x 20') | $300 | $9,000 | |
| 700 | LF | Site Fence | $15 | $10,500 | $24,500 |
| | | INSTALLATION | | | |
| 1 | LS | Mechanical | $66,000 | $66,000 | |
| 1 | LS | Electrical (15% of ME) | $33,000 | $33,000 | |
| 1 | EA | Structure (20' x 20' x 10') | $22,000 | $22,000 | |
| 1 | LS | 18" Gravity Sewer -NPDES dischg | $42,000 | $42,000 | |
| 1 | LS | Relocate/Refit Chemical Systems | $5,000 | $5,000 | $168,000 |
| | | INDIRECT | | | |
| 1 | LS | Engineering/Constr. Man. (20% of Installed Cost) | | | $142,600 |
| 1 | LS | Contingency (10% of Installed Cost) | | | $71,300 |
| 1 | LS | Pilot Treatability Study | | | $40,000 |
| | | | | TOTAL | $967,000 |

## ALTERNATIVE FIVE: TREATMENT OF GROUNDWATER USING GAC ADSORPTION

## CAPITAL COSTS

| QTY | UNIT | DESCRIPTION | UNIT COST | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|
| | | MAJOR EQUIPMENT | | | |
| 6 | EA | Carbon Cells/Carbon | $70,000 | $420,000 | |
| 2 | EA | Vert Well Pump (2200 gpm, 40 hp) | $11,300 | $22,600 | |
| 3 | EA | HP Centr. Pump (700 gpm, 100 hp) | $14,500 | $43,500 | |
| 1 | EA | Standby Generator - Diesel | $70,000 | $70,000 | |
| 1 | EA | 500 gal Aboveground Fuel Tank | $2,000 | $2,000 | |
| 1 | EA | CS SuctionTank (5,000 gal) | $8,000 | $8,000 | $566,100 |
| | | ANCILLARY EQUIPMENT | | | |
| 1 | LS | Piping/Valves/Appurtanences | $65,000 | $65,000 | |
| 1 | LS | Controls | $28,500 | $28,500 | |
| 1 | LS | Electrical | $45,000 | $45,000 | |
| 1 | LS | Shipping | $28,500 | $28,500 | $167,000 |
| | | SITE PREPARATION | | | |
| 1 | LS | Earth Work | $7,000 | $7,000 | |
| 40 | CY | Foundation (40' x 40') | $300 | $12,000 | |
| 700 | LF | Site Fence | $15 | $10,500 | $29,500 |
| | | INSTALLATION | | | |
| 1 | LS | Mechanical | $85,000 | $85,000 | |
| 1 | LS | Electrical | $56,500 | $56,500 | |
| 1 | EA | Structure (40' x 40' x 15') | $75,000 | $75,000 | |
| 1 | LS | 18" Gravity Sewer -NPDES dischg | $42,000 | $42,000 | |
| 1 | LS | Relocate/Refit Chemical Systems | $5,000 | $5,000 | $263,500 |
| | | INDIRECT | | | |
| 1 | LS | Engineering/Constr. Man. (20% of Installed Cost) | | | $205,200 |
| 1 | LS | Contingency (10% of Installed Cost) | | | $102,600 |
| 1 | LS | Pilot Treatability Study | | | $25,000 |
| | | | | TOTAL | $1,359,000 |

**ALTERNATIVE FOUR: TREATMENT OF GROUNDWATER USING AIR STRIPPING**

**ANNUAL OPERATING COSTS**

| | DESCRIPTION | UNIT | QTY | UNIT PRICE | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|---|
| 1. | STRIPPER OPERATION | | | | | |
| | Electricity (constant blower and pump op) | KWHR | 750,000 | $0.08 | $60,000 | |
| | Building Heating (winter operation) | LS | 1 | $7,500 | $7,500 | |
| | System Monitoring (2 hr/day; 365 days/yr) | HR | 730 | $35 | $25,550 | $93,100 |
| 2. | SAMPLING | | | | | |
| | Stripper Influent/Effluent (2 hr/week; 52 weeks/yr) | HR | 104 | $35 | $3,640 | |
| | Monitoring Wells (2 days quarterly; 2 technicians) | HR | 160 | $35 | $5,600 | |
| | Equipment (containers,etc.) | LS | 1 | $5,000 | $5,000 | |
| | Air Monitoring (1 hr/day; 365 days/yr) | HR | 365 | $35 | $12,775 | $27,000 |
| 3. | ANALYTICAL | | | | | |
| | Weekly Influent/Effluent | EA | 52 | $450 | $23,400 | |
| | Quarterly Monitoring Wells (6 wells; duplicate analyses) | EA | 4 | $1,350 | $5,400 | $28,800 |
| 4. | Packing Change (every 10 years) | | | | | |
| | Replacement Packing | CF | 470 | $9 | $4,230 | |
| | Equipment Rental | DAY | 0.4 | $100 | $40 | |
| | Labor | HR | 4 | $35 | $140 | |
| | Transport/Disposal | TON | 0.8 | $50 | $40 | $4,500 |
| 5. | MISCELLANEOUS REPAIRS (10%) | | | | | $15,300 |
| | | | | | TOTAL | $169,000 |

**ALTERNATIVE FIVE: TREATMENT OF GROUNDWATER USING GAC ADSORPTION**

**ANNUAL OPERATING COSTS**

| | DESCRIPTION | UNIT | QTY | UNIT PRICE | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|---|
| 1. | CARBON CELL OPERATION | | | | | |
| | Electricity (constant pump op) | KWHR | 600,000 | $0.08 | $48,000 | |
| | Building Heating (winter operation) | LS | 1 | $10,000 | $10,000 | |
| | System Monitoring (2 hr/day; 365 days/yr) | HR | 730 | $35 | $25,550 | $83,600 |
| 2. | SAMPLING | | | | | |
| | Carbon Influent/Effluent (2 hr/week; 52 weeks/yr) | HR | 104 | $35 | $3,640 | |
| | Monitoring Wells (2 days quarterly; 2 techs) | HR | 160 | $35 | $5,600 | |
| | Equipment (containers,etc.) | LS | 1 | $7,500 | $7,500 | |
| | Air Monitoring (1 hr/day; 365 days/yr) | HR | 365 | $35 | $12,775 | $29,500 |
| 3. | ANALYTICAL | | | | | |
| | Weekly Influent/Effluent | EA | 52 | $450 | $23,400 | |
| | Quarterly Monitoring Wells (6 wells; duplicate analyses) | EA | 4 | $1,350 | $5,400 | $28,800 |
| 4. | CARBON CHANGE (5 cells/3 years; $27,000/change) | LS | 1 | $45,000 | $45,000 | $45,000 |
| 5. | MISCELLANEOUS REPAIRS (10%) | | | | | $18,700 |
| | | | | | TOTAL | $206,000 |

## ALTERNATIVE FOUR: NPV CALCULATION

**INTEREST RATE:** **0.05**

Investment: $967,000
Annual Expenses: $169,000

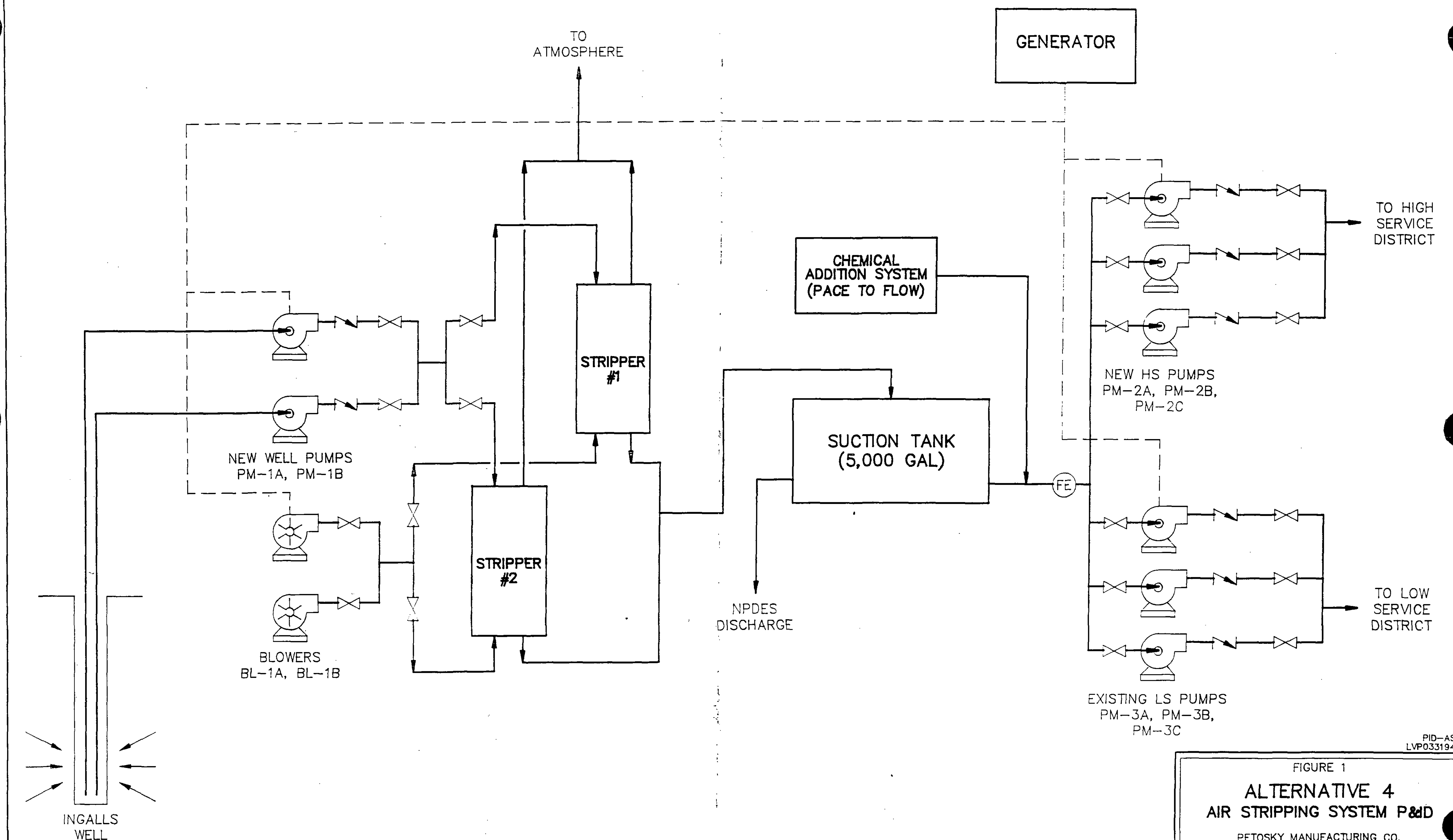
| YEAR | INVESTMENT | EXPENSES | CASH FLOW | DISCOUNT FACTOR | DISCOUNTED CASH FLOW |
|---|---|---|---|---|---|
| 0 | $967,000 | $0 | ($967,000) | 1.000 | ($967,000) |
| 1 | $0 | $169,000 | ($169,000) | 0.952 | ($160,952) |
| 2 | $0 | $169,000 | ($169,000) | 0.907 | ($153,288) |
| 3 | $0 | $169,000 | ($169,000) | 0.864 | ($145,989) |
| 4 | $0 | $169,000 | ($169,000) | 0.823 | ($139,037) |
| 5 | $0 | $169,000 | ($169,000) | 0.784 | ($132,416) |
| 6 | $0 | $169,000 | ($169,000) | 0.746 | ($126,110) |
| 7 | $0 | $169,000 | ($169,000) | 0.711 | ($120,105) |
| 8 | $0 | $169,000 | ($169,000) | 0.677 | ($114,386) |
| 9 | $0 | $169,000 | ($169,000) | 0.645 | ($108,939) |
| 10 | $0 | $169,000 | ($169,000) | 0.614 | ($103,751) |
| 11 | $0 | $169,000 | ($169,000) | 0.585 | ($98,811) |
| 12 | $0 | $169,000 | ($169,000) | 0.557 | ($94,106) |
| 13 | $0 | $169,000 | ($169,000) | 0.530 | ($89,624) |
| 14 | $0 | $169,000 | ($169,000) | 0.505 | ($85,356) |
| 15 | $0 | $169,000 | ($169,000) | 0.481 | ($81,292) |
| 16 | $0 | $169,000 | ($169,000) | 0.458 | ($77,421) |
| 17 | $0 | $169,000 | ($169,000) | 0.436 | ($73,734) |
| 18 | $0 | $169,000 | ($169,000) | 0.416 | ($70,223) |
| 19 | $0 | $169,000 | ($169,000) | 0.396 | ($66,879) |
| 20 | $0 | $169,000 | ($169,000) | 0.377 | ($63,694) |
| 21 | $0 | $169,000 | ($169,000) | 0.359 | ($60,661) |
| 22 | $0 | $169,000 | ($169,000) | 0.342 | ($57,773) |
| 23 | $0 | $169,000 | ($169,000) | 0.326 | ($55,022) |
| 24 | $0 | $169,000 | ($169,000) | 0.310 | ($52,401) |
| 25 | $0 | $169,000 | ($169,000) | 0.295 | ($49,906) |
| 26 | $0 | $169,000 | ($169,000) | 0.281 | ($47,530) |
| 27 | $0 | $169,000 | ($169,000) | 0.268 | ($45,266) |
| 28 | $0 | $169,000 | ($169,000) | 0.255 | ($43,111) |
| 29 | $0 | $169,000 | ($169,000) | 0.243 | ($41,058) |
| 30 | $0 | $169,000 | ($169,000) | 0.231 | ($39,103) |
| Totals: | $967,000 | $5,070,000 | ($6,037,000) | | ($3,564,944) |

## ALTERNATIVE FIVE: NPV CALCULATION

**INTEREST RATE:** **0.05**

Investment: $1,359,000
Annual Expenses: $206,000

| YEAR | INVESTMENT | EXPENSES | CASH FLOW | DISCOUNT FACTOR | DISCOUNTED CASH FLOW |
|---|---|---|---|---|---|
| 0 | $1,359,000 | $0 | ($1,359,000) | 1.000 | ($1,359,000) |
| 1 | $0 | $206,000 | ($206,000) | 0.952 | ($196,190) |
| 2 | $0 | $206,000 | ($206,000) | 0.907 | ($186,848) |
| 3 | $0 | $206,000 | ($206,000) | 0.864 | ($177,951) |
| 4 | $0 | $206,000 | ($206,000) | 0.823 | ($169,477) |
| 5 | $0 | $206,000 | ($206,000) | 0.784 | ($161,406) |
| 6 | $0 | $206,000 | ($206,000) | 0.746 | ($153,720) |
| 7 | $0 | $206,000 | ($206,000) | 0.711 | ($146,400) |
| 8 | $0 | $206,000 | ($206,000) | 0.677 | ($139,429) |
| 9 | $0 | $206,000 | ($206,000) | 0.645 | ($132,789) |
| 10 | $0 | $206,000 | ($206,000) | 0.614 | ($126,466) |
| 11 | $0 | $206,000 | ($206,000) | 0.585 | ($120,444) |
| 12 | $0 | $206,000 | ($206,000) | 0.557 | ($114,709) |
| 13 | $0 | $206,000 | ($206,000) | 0.530 | ($109,246) |
| 14 | $0 | $206,000 | ($206,000) | 0.505 | ($104,044) |
| 15 | $0 | $206,000 | ($206,000) | 0.481 | ($99,090) |
| 16 | $0 | $206,000 | ($206,000) | 0.458 | ($94,371) |
| 17 | $0 | $206,000 | ($206,000) | 0.436 | ($89,877) |
| 18 | $0 | $206,000 | ($206,000) | 0.416 | ($85,597) |
| 19 | $0 | $206,000 | ($206,000) | 0.396 | ($81,521) |
| 20 | $0 | $206,000 | ($206,000) | 0.377 | ($77,639) |
| 21 | $0 | $206,000 | ($206,000) | 0.359 | ($73,942) |
| 22 | $0 | $206,000 | ($206,000) | 0.342 | ($70,421) |
| 23 | $0 | $206,000 | ($206,000) | 0.326 | ($67,068) |
| 24 | $0 | $206,000 | ($206,000) | 0.310 | ($63,874) |
| 25 | $0 | $206,000 | ($206,000) | 0.295 | ($60,832) |
| 26 | $0 | $206,000 | ($206,000) | 0.281 | ($57,936) |
| 27 | $0 | $206,000 | ($206,000) | 0.268 | ($55,177) |
| 28 | $0 | $206,000 | ($206,000) | 0.255 | ($52,549) |
| 29 | $0 | $206,000 | ($206,000) | 0.243 | ($50,047) |
| 30 | $0 | $206,000 | ($206,000) | 0.231 | ($47,664) |
| Totals: | $1,359,000 | $6,180,000 | ($7,539,000) | | ($4,525,725) |




PID-AS
LVP033194

FIGURE 1

ALTERNATIVE 4
AIR STRIPPING SYSTEM P&ID

PETOSKY MANUFACTURING CO.
PETOSKY, MICHIGAN

APRIL, 1994 04014.05

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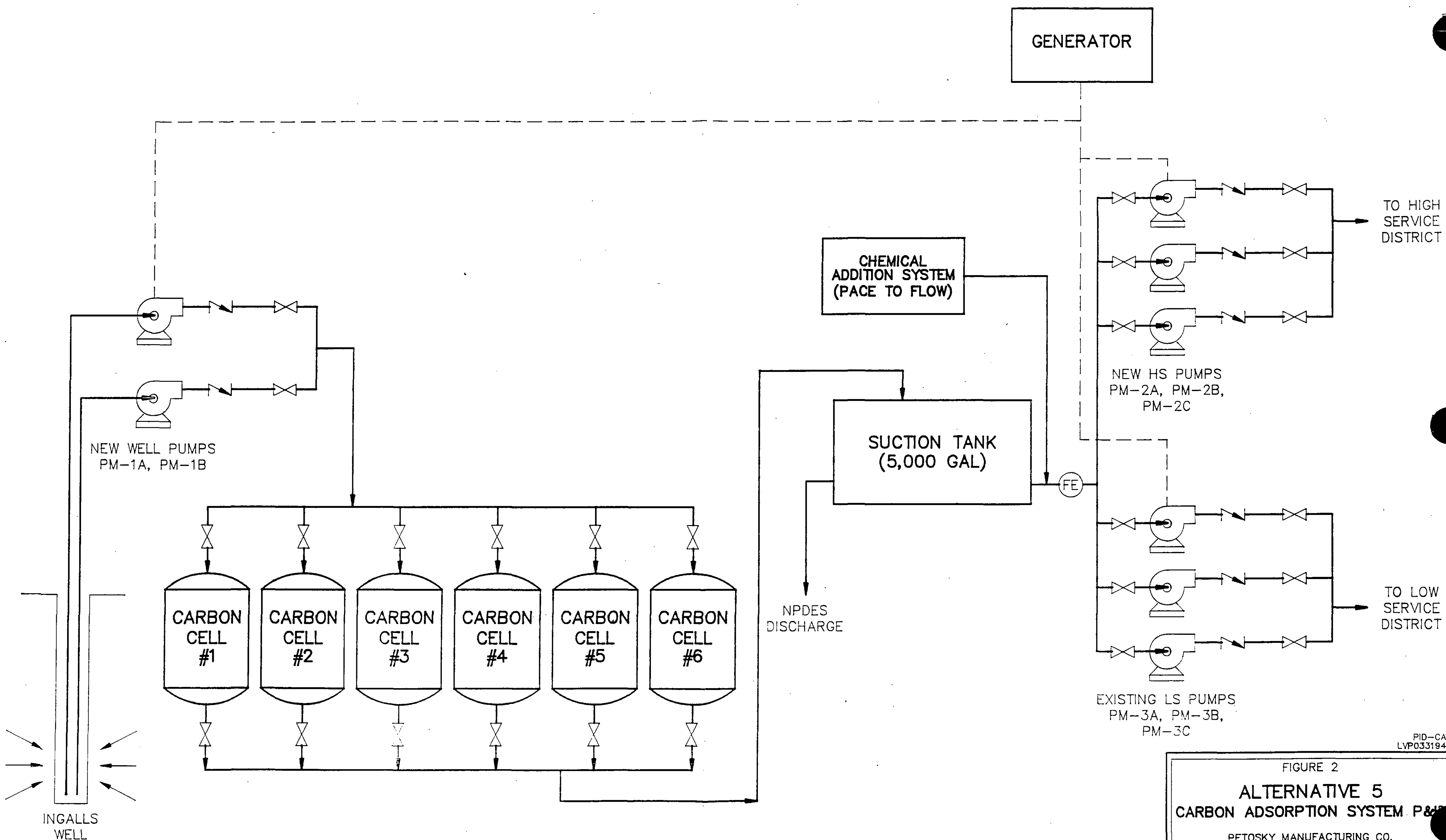


PID-CA
LVP033194

FIGURE 2

ALTERNATIVE 5

CARBON ADSORPTION SYSTEM P&ID

PETOSKY MANUFACTURING CO.
PETOSKY, MICHIGAN

APRIL, 1994

04014.05

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**ALTERNATIVE FOUR: TREATMENT OF GROUNDWATER USING AIR STRIPPING**

**CAPITAL COSTS**

| QTY | UNIT | DESCRIPTION | UNIT COST | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|
| | | MAJOR EQUIPMENT | | | |
| 2 | EA | Stripper Shell (FRP-14' diam.) | $45,000 | $90,000 | |
| 2 | LS | Packing Support/Liquid Distr. | $42,500 | $85,000 | |
| 4,620 | CF | Packing | $9 | $41,580 | |
| 2 | EA | Blower (12,000 cfm, 40hp) | $6,500 | $13,000 | |
| 2 | EA | Vert Well Pump (2200 gpm, 40 hp) | $11,300 | $22,600 | |
| 3 | EA | HP Centr. Pump (700 gpm, 100 hp) | $14,500 | $43,500 | |
| 1 | EA | Standby Generator - Diesel | $80,000 | $80,000 | |
| 1 | EA | 500 gal Aboveground Fuel Tank | $2,000 | $2,000 | |
| 1 | EA | CS Suction Tank (5,000 gal) | $8,000 | $8,000 | $385,700 |
| | | ANCILLARY EQUIPMENT | | | |
| 1 | LS | Piping/Valves/Appurtanences | $49,000 | $49,000 | |
| 1 | LS | Controls | $26,500 | $26,500 | |
| 1 | LS | Electrical | $33,000 | $33,000 | |
| 1 | LS | Insulation | $10,000 | $10,000 | |
| 1 | LS | Shipping | $16,500 | $16,500 | $135,000 |
| | | SITE PREPARATION | | | |
| 1 | LS | Earth Work | $5,000 | $5,000 | |
| 30 | CY | Foundation (35' x 20') | $300 | $9,000 | |
| 700 | LF | Site Fence | $15 | $10,500 | $24,500 |
| | | INSTALLATION | | | |
| 1 | LS | Mechanical | $66,000 | $66,000 | |
| 1 | LS | Electrical (15% of ME) | $33,000 | $33,000 | |
| 1 | EA | Structure (20' x 20' x 10') | $22,000 | $22,000 | |
| 1 | LS | 18" Gravity Sewer -NPDES dischg | $42,000 | $42,000 | |
| 1 | LS | Relocate/Refit Chemical Systems | $5,000 | $5,000 | $168,000 |
| | | INDIRECT | | | |
| 1 | LS | Engineering/Constr. Man. (20% of Installed Cost) | | | $142,600 |
| 1 | LS | Contingency (10% of Installed Cost) | | | $71,300 |
| 1 | LS | Pilot Treatability Study | | | $40,000 |
| | | | | TOTAL | $967,000 |

## ALTERNATIVE FIVE: TREATMENT OF GROUNDWATER USING GAC ADSORPTION

## CAPITAL COSTS

| QTY | UNIT | DESCRIPTION | UNIT COST | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|
| | | MAJOR EQUIPMENT | | | |
| 6 | EA | Carbon Cells/Carbon | $70,000 | $420,000 | |
| 2 | EA | Vert Well Pump (2200 gpm, 40 hp) | $11,300 | $22,600 | |
| 3 | EA | HP Centr. Pump (700 gpm, 100 hp) | $14,500 | $43,500 | |
| 1 | EA | Standby Generator - Diesel | $70,000 | $70,000 | |
| 1 | EA | 500 gal Aboveground Fuel Tank | $2,000 | $2,000 | |
| 1 | EA | CS SuctionTank (5,000 gal) | $8,000 | $8,000 | $566,100 |
| | | ANCILLARY EQUIPMENT | | | |
| 1 | LS | Piping/Valves/Appurtanences | $65,000 | $65,000 | |
| 1 | LS | Controls | $28,500 | $28,500 | |
| 1 | LS | Electrical | $45,000 | $45,000 | |
| 1 | LS | Shipping | $28,500 | $28,500 | $167,000 |
| | | SITE PREPARATION | | | |
| 1 | LS | Earth Work | $7,000 | $7,000 | |
| 40 | CY | Foundation (40' x 40') | $300 | $12,000 | |
| 700 | LF | Site Fence | $15 | $10,500 | $29,500 |
| | | INSTALLATION | | | |
| 1 | LS | Mechanical | $85,000 | $85,000 | |
| 1 | LS | Electrical | $56,500 | $56,500 | |
| 1 | EA | Structure (40' x 40' x 15') | $75,000 | $75,000 | |
| 1 | LS | 18" Gravity Sewer -NPDES dischg | $42,000 | $42,000 | |
| 1 | LS | Relocate/Refit Chemical Systems | $5,000 | $5,000 | $263,500 |
| | | INDIRECT | | | |
| 1 | LS | Engineering/Constr. Man. (20% of Installed Cost) | | | $205,200 |
| 1 | LS | Contingency (10% of Installed Cost) | | | $102,600 |
| 1 | LS | Pilot Treatability Study | | | $25,000 |
| | | | | TOTAL | $1,359,000 |

## ALTERNATIVE FOUR: TREATMENT OF GROUNDWATER USING AIR STRIPPING

## ANNUAL OPERATING COSTS

| | DESCRIPTION | UNIT | QTY | UNIT PRICE | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|---|
| 1. | STRIPPER OPERATION | | | | | |
| | Electricity<br>(constant blower and pump op) | KWHR | 750,000 | $0.08 | $60,000 | |
| | Building Heating<br>(winter operation) | LS | 1 | $7,500 | $7,500 | |
| | System Monitoring<br>(2 hr/day; 365 days/yr) | HR | 730 | $35 | $25,550 | $93,100 |
| 2. | SAMPLING | | | | | |
| | Stripper Influent/Effluent<br>(2 hr/week; 52 weeks/yr) | HR | 104 | $35 | $3,640 | |
| | Monitoring Wells<br>(2 days quarterly; 2 technicians) | HR | 160 | $35 | $5,600 | |
| | Equipment<br>(containers,etc.) | LS | 1 | $5,000 | $5,000 | |
| | Air Monitoring<br>(1 hr/day; 365 days/yr) | HR | 365 | $35 | $12,775 | $27,000 |
| 3. | ANALYTICAL | | | | | |
| | Weekly Influent/Effluent | EA | 52 | $450 | $23,400 | |
| | Quarterly Monitoring Wells<br>(6 wells; duplicate analyses) | EA | 4 | $1,350 | $5,400 | $28,800 |
| 4. | Packing Change (every 10 years) | | | | | |
| | Replacement Packing | CF | 470 | $9 | $4,230 | |
| | Equipment Rental | DAY | 0.4 | $100 | $40 | |
| | Labor | HR | 4 | $35 | $140 | |
| | Transport/Disposal | TON | 0.8 | $50 | $40 | $4,500 |
| 5. | MISCELLANEOUS REPAIRS (10%) | | | | | $15,300 |
| | | | | | TOTAL | $169,000 |

**ALTERNATIVE FIVE: TREATMENT OF GROUNDWATER USING GAC ADSORPTION**

**ANNUAL OPERATING COSTS**

| | DESCRIPTION | UNIT | QTY | UNIT PRICE | TOTAL COST | SUBTOTAL |
|---|---|---|---|---|---|---|
| 1. | CARBON CELL OPERATION | | | | | |
| | Electricity (constant pump op) | KWHR | 600,000 | $0.08 | $48,000 | |
| | Building Heating (winter operation) | LS | 1 | $10,000 | $10,000 | |
| | System Monitoring (2 hr/day; 365 days/yr) | HR | 730 | $35 | $25,550 | $83,600 |
| 2. | SAMPLING | | | | | |
| | Carbon Influent/Effluent (2 hr/week; 52 weeks/yr) | HR | 104 | $35 | $3,640 | |
| | Monitoring Wells (2 days quarterly; 2 techs) | HR | 160 | $35 | $5,600 | |
| | Equipment (containers,etc.) | LS | 1 | $7,500 | $7,500 | |
| | Air Monitoring (1 hr/day; 365 days/yr) | HR | 365 | $35 | $12,775 | $29,500 |
| 3. | ANALYTICAL | | | | | |
| | Weekly Influent/Effluent | EA | 52 | $450 | $23,400 | |
| | Quarterly Monitoring Wells (6 wells; duplicate analyses) | EA | 4 | $1,350 | $5,400 | $28,800 |
| 4. | CARBON CHANGE (5 cells/3 years; $27,000/change) | LS | 1 | $45,000 | $45,000 | $45,000 |
| 5. | MISCELLANEOUS REPAIRS (10%) | | | | | $18,700 |
| | | | | | TOTAL | $206,000 |

**ALTERNATIVE FOUR: NPV CALCULATION**

| | | | |
|---|---|---|---|
| **INTEREST RATE:** | **0.05** | Investment: | $967,000 |
| | | Annual Expenses: | $169,000 |

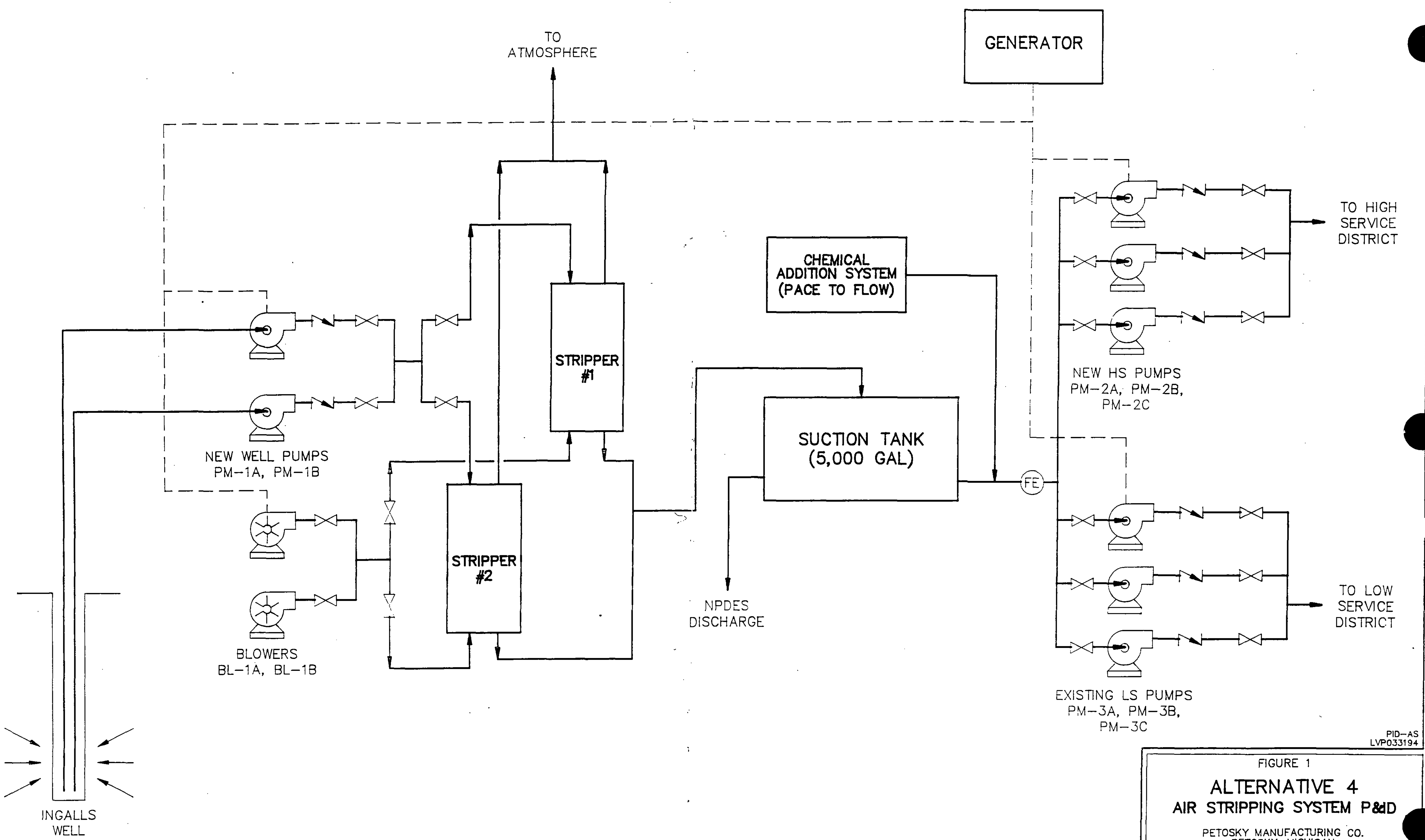
| YEAR | INVESTMENT | EXPENSES | CASH FLOW | DISCOUNT FACTOR | DISCOUNTED CASH FLOW |
|---|---|---|---|---|---|
| 0 | $967,000 | $0 | ($967,000) | 1.000 | ($967,000) |
| 1 | $0 | $169,000 | ($169,000) | 0.952 | ($160,952) |
| 2 | $0 | $169,000 | ($169,000) | 0.907 | ($153,288) |
| 3 | $0 | $169,000 | ($169,000) | 0.864 | ($145,989) |
| 4 | $0 | $169,000 | ($169,000) | 0.823 | ($139,037) |
| 5 | $0 | $169,000 | ($169,000) | 0.784 | ($132,416) |
| 6 | $0 | $169,000 | ($169,000) | 0.746 | ($126,110) |
| 7 | $0 | $169,000 | ($169,000) | 0.711 | ($120,105) |
| 8 | $0 | $169,000 | ($169,000) | 0.677 | ($114,386) |
| 9 | $0 | $169,000 | ($169,000) | 0.645 | ($108,939) |
| 10 | $0 | $169,000 | ($169,000) | 0.614 | ($103,751) |
| 11 | $0 | $169,000 | ($169,000) | 0.585 | ($98,811) |
| 12 | $0 | $169,000 | ($169,000) | 0.557 | ($94,106) |
| 13 | $0 | $169,000 | ($169,000) | 0.530 | ($89,624) |
| 14 | $0 | $169,000 | ($169,000) | 0.505 | ($85,356) |
| 15 | $0 | $169,000 | ($169,000) | 0.481 | ($81,292) |
| 16 | $0 | $169,000 | ($169,000) | 0.458 | ($77,421) |
| 17 | $0 | $169,000 | ($169,000) | 0.436 | ($73,734) |
| 18 | $0 | $169,000 | ($169,000) | 0.416 | ($70,223) |
| 19 | $0 | $169,000 | ($169,000) | 0.396 | ($66,879) |
| 20 | $0 | $169,000 | ($169,000) | 0.377 | ($63,694) |
| 21 | $0 | $169,000 | ($169,000) | 0.359 | ($60,661) |
| 22 | $0 | $169,000 | ($169,000) | 0.342 | ($57,773) |
| 23 | $0 | $169,000 | ($169,000) | 0.326 | ($55,022) |
| 24 | $0 | $169,000 | ($169,000) | 0.310 | ($52,401) |
| 25 | $0 | $169,000 | ($169,000) | 0.295 | ($49,906) |
| 26 | $0 | $169,000 | ($169,000) | 0.281 | ($47,530) |
| 27 | $0 | $169,000 | ($169,000) | 0.268 | ($45,266) |
| 28 | $0 | $169,000 | ($169,000) | 0.255 | ($43,111) |
| 29 | $0 | $169,000 | ($169,000) | 0.243 | ($41,058) |
| 30 | $0 | $169,000 | ($169,000) | 0.231 | ($39,103) |
| Totals: | $967,000 | $5,070,000 | ($6,037,000) | | ($3,564,944) |

## ALTERNATIVE FIVE: NPV CALCULATION

**INTEREST RATE:** **0.05**

Investment: $1,359,000
Annual Expenses: $206,000

| YEAR | INVESTMENT | EXPENSES | CASH FLOW | DISCOUNT FACTOR | DISCOUNTED CASH FLOW |
|---|---|---|---|---|---|
| 0 | $1,359,000 | $0 | ($1,359,000) | 1.000 | ($1,359,000) |
| 1 | $0 | $206,000 | ($206,000) | 0.952 | ($196,190) |
| 2 | $0 | $206,000 | ($206,000) | 0.907 | ($186,848) |
| 3 | $0 | $206,000 | ($206,000) | 0.864 | ($177,951) |
| 4 | $0 | $206,000 | ($206,000) | 0.823 | ($169,477) |
| 5 | $0 | $206,000 | ($206,000) | 0.784 | ($161,406) |
| 6 | $0 | $206,000 | ($206,000) | 0.746 | ($153,720) |
| 7 | $0 | $206,000 | ($206,000) | 0.711 | ($146,400) |
| 8 | $0 | $206,000 | ($206,000) | 0.677 | ($139,429) |
| 9 | $0 | $206,000 | ($206,000) | 0.645 | ($132,789) |
| 10 | $0 | $206,000 | ($206,000) | 0.614 | ($126,466) |
| 11 | $0 | $206,000 | ($206,000) | 0.585 | ($120,444) |
| 12 | $0 | $206,000 | ($206,000) | 0.557 | ($114,709) |
| 13 | $0 | $206,000 | ($206,000) | 0.530 | ($109,246) |
| 14 | $0 | $206,000 | ($206,000) | 0.505 | ($104,044) |
| 15 | $0 | $206,000 | ($206,000) | 0.481 | ($99,090) |
| 16 | $0 | $206,000 | ($206,000) | 0.458 | ($94,371) |
| 17 | $0 | $206,000 | ($206,000) | 0.436 | ($89,877) |
| 18 | $0 | $206,000 | ($206,000) | 0.416 | ($85,597) |
| 19 | $0 | $206,000 | ($206,000) | 0.396 | ($81,521) |
| 20 | $0 | $206,000 | ($206,000) | 0.377 | ($77,639) |
| 21 | $0 | $206,000 | ($206,000) | 0.359 | ($73,942) |
| 22 | $0 | $206,000 | ($206,000) | 0.342 | ($70,421) |
| 23 | $0 | $206,000 | ($206,000) | 0.326 | ($67,068) |
| 24 | $0 | $206,000 | ($206,000) | 0.310 | ($63,874) |
| 25 | $0 | $206,000 | ($206,000) | 0.295 | ($60,832) |
| 26 | $0 | $206,000 | ($206,000) | 0.281 | ($57,936) |
| 27 | $0 | $206,000 | ($206,000) | 0.268 | ($55,177) |
| 28 | $0 | $206,000 | ($206,000) | 0.255 | ($52,549) |
| 29 | $0 | $206,000 | ($206,000) | 0.243 | ($50,047) |
| 30 | $0 | $206,000 | ($206,000) | 0.231 | ($47,664) |
| Totals: | $1,359,000 | $6,180,000 | ($7,539,000) | | ($4,525,725) |




PID-AS
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FIGURE 1

ALTERNATIVE 4
AIR STRIPPING SYSTEM P&ID

PETOSKY MANUFACTURING CO.
PETOSKY, MICHIGAN

APRIL, 1994

04014.05

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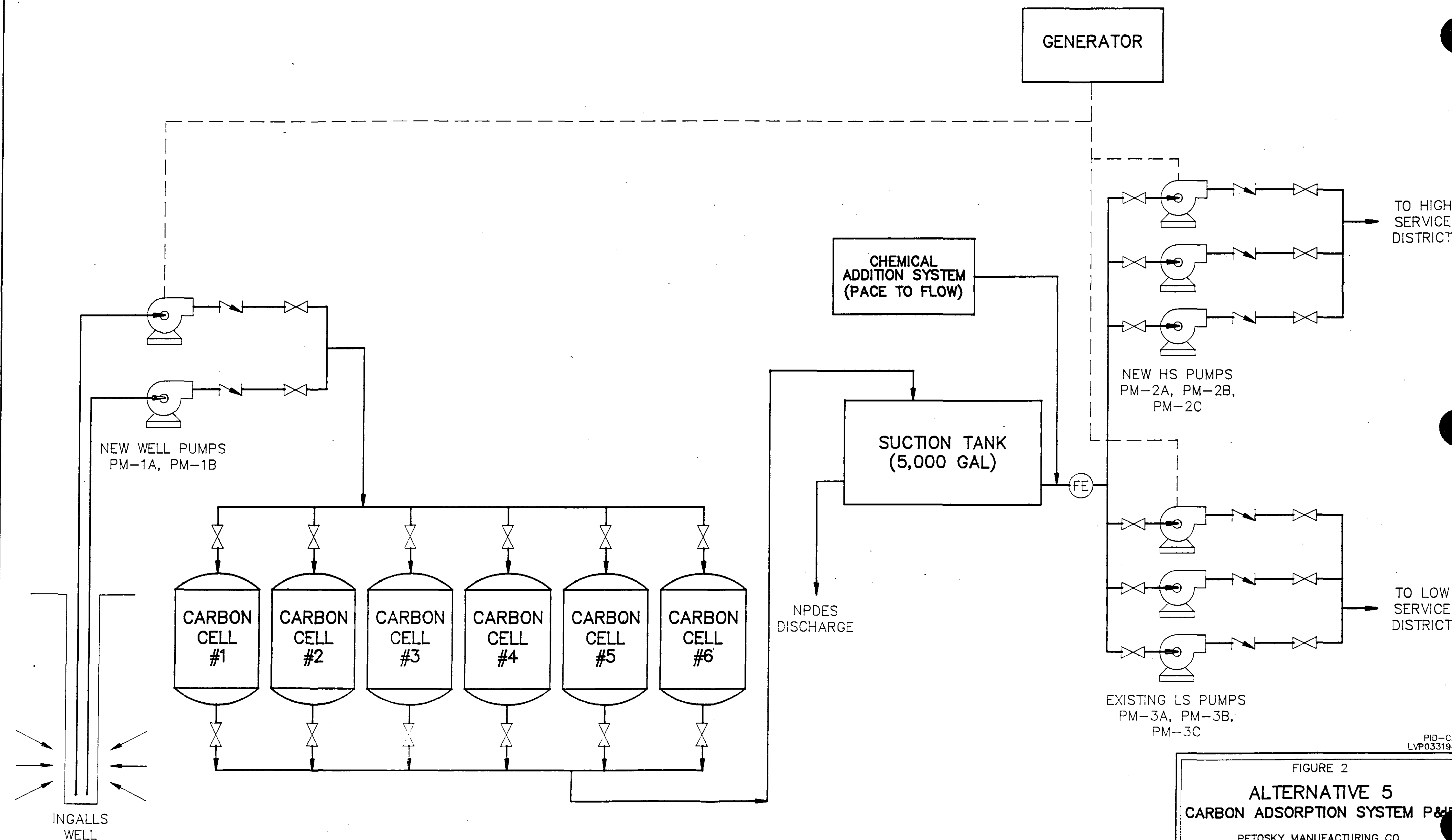


FIGURE 2

ALTERNATIVE 5

CARBON ADSORPTION SYSTEM P&

PETOSKY MANUFACTURING CO.
PETOSKY, MICHIGAN

APRIL, 1994 04014.05

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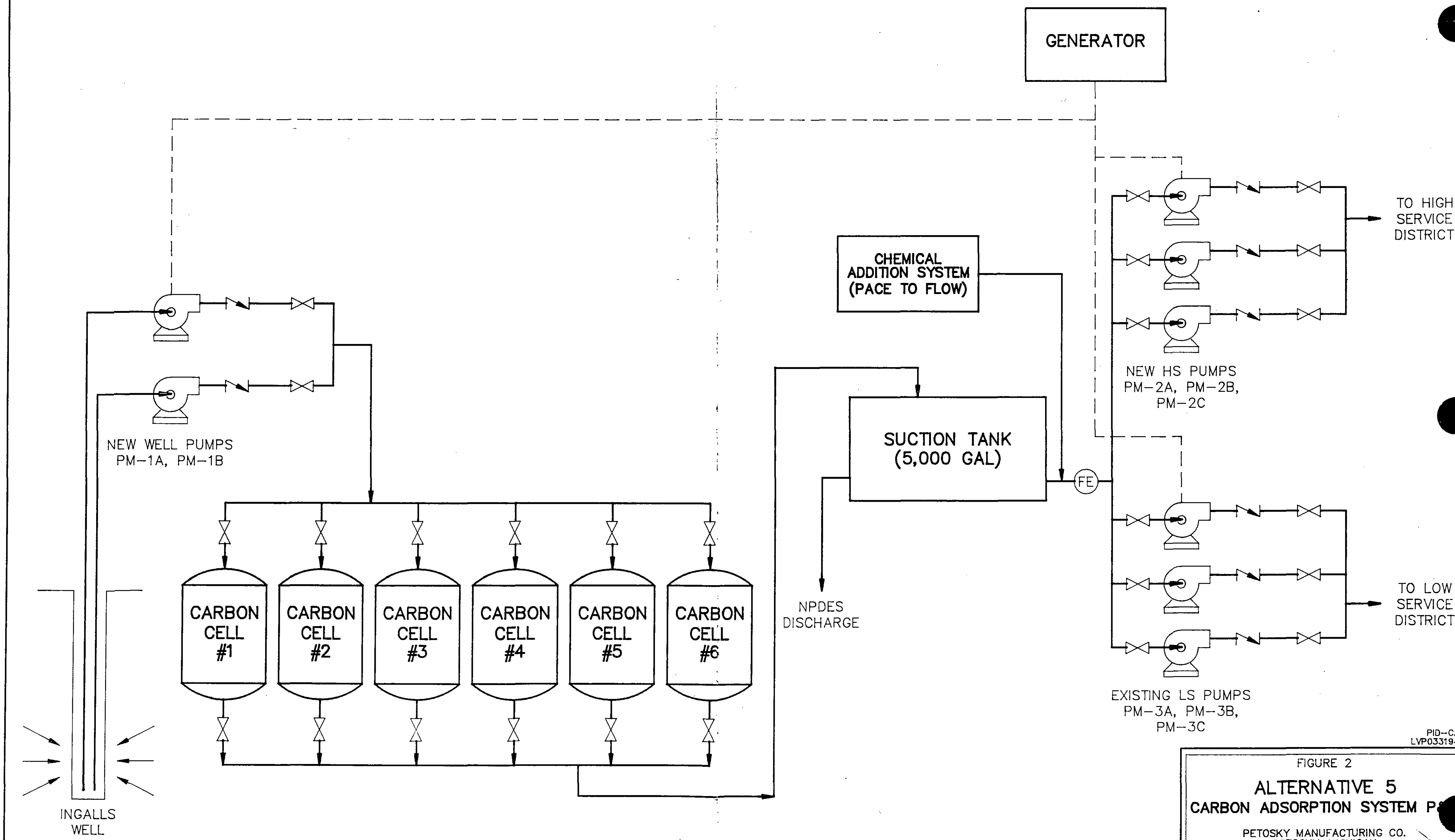


PID-CA
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FIGURE 2

ALTERNATIVE 5

CARBON ADSORPTION SYSTEM P

PETOSKY MANUFACTURING CO.
PETOSKY, MICHIGAN

APRIL, 1994

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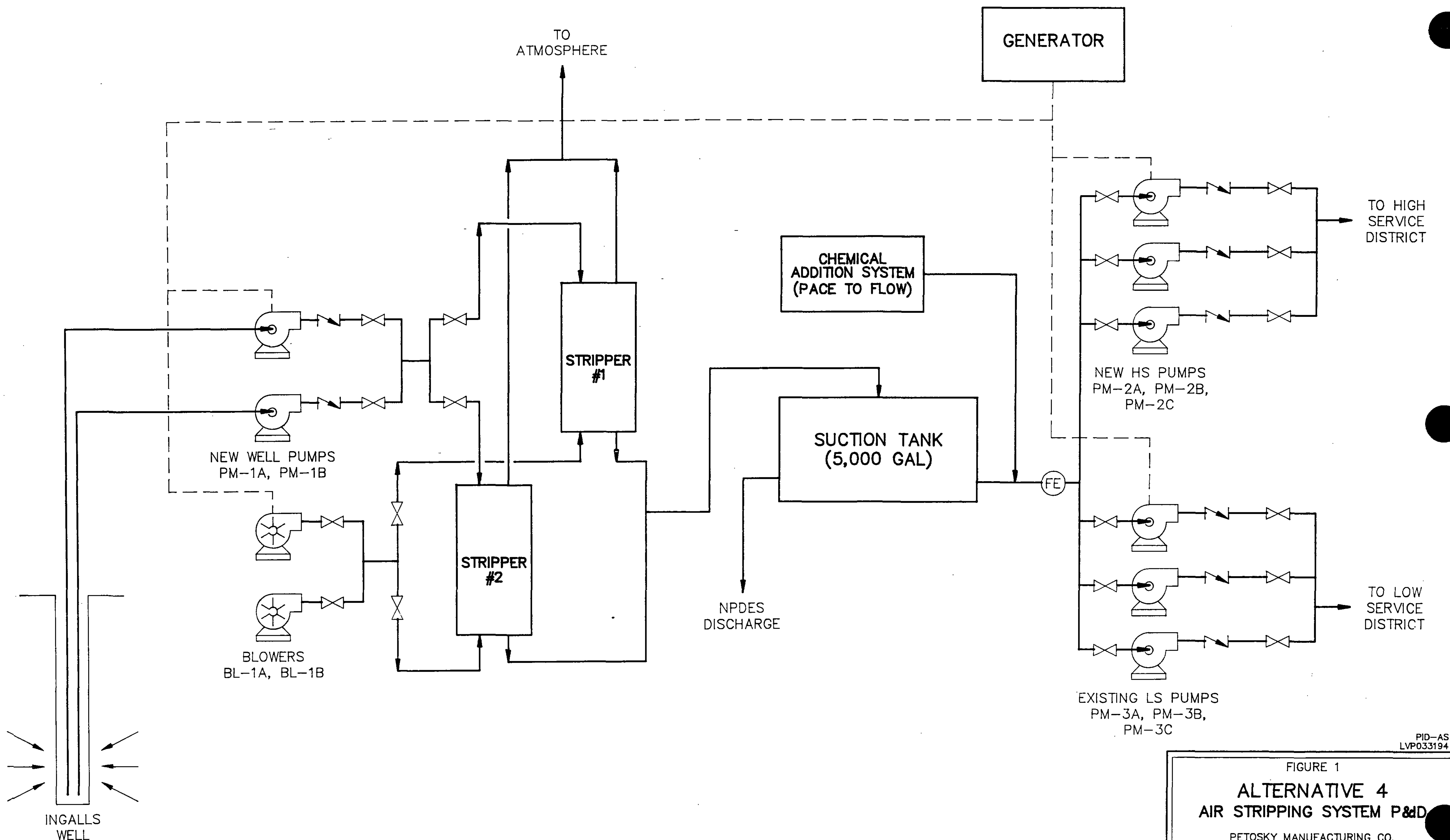


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FIGURE 1

ALTERNATIVE 4

AIR STRIPPING SYSTEM P&ID

PETOSKY MANUFACTURING CO.
PETOSKY, MICHIGAN

APRIL, 1994

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